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ABSTRACT

This paper reports a study of cerebral dominance in 42 preschool and kindergarten children. In order to tap left hemisphere functioning, a story of approximately 650 words and 77 specific plot details was composed. Children listened to the 7 minute story and were asked to repeat it. Responses were taped. Tangram pieces were used to assess right hemisphere functioning. Twelve puzzles were presented to each child, using from two to six tangram pieces. In addition, records of handedness and eye dominance were obtained. Each child was tested in two sessions on different days. All subjects required prompts on the story task. Similarly, prompting was used with the Tangram puzzles when the child seemed unable to proceed. Results of individual profile analyses indicated that 50% of the children had major discrepancies in hemispheric functioning. Children between the ages of five and six appeared to have clear differences in "learning styles" or "strengths." The relationship of the findings to reading failure is briefly suggested. (Author/RH)

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AUDITORY ATTENDING SKILLS

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Auditory Attending Skills

First of all, I would like to explain how I got interested in the topic of young children's auditory attending skills. I have been both a teacher of, and, probably more important, a student of young children since 1942 when I worked as a research associate at the Fels Research Institute in Yellow Springs, Ohio. In the intervening years between then and now, I have worked as a preschool teacher, a pediatric social worker, a teacher of emotionally disturbed children, a parent educator, and a teacher of kindergarten, first grade and second grade children. It was as a result of trying to teach children to read that I became deeply aware of the different approaches and difficulties which young children had in beginning to read. It was at about this time that I read J.MCV. Hunt's marvelous expository book Intelligence and Experience and began looking more critically at the way we try to teach children. After spending two more years teaching children with learning problems, I decided to concentrate my interests in this area, returned to academia and emerged 2 years later with a degree in reading and a test to try to assess differences in auditory skills.

Briefly, this test was a 7 minute cassette tape based on the International Code with children presented electronic sets of sounds ranging from a beginning 2 bit impulse to 4 bits. If both sets of sounds seemed to be the same, the child simply had to nod "Yes." The total possible score was 15. My object was

to try to identify whether children were lacking in auditory discrimination skills before they were started in a reading program, hypothesizing that children who had auditory deficits should not be placed in a strongly based phonics program to start. To date I have used this test with some 500 or more children, ranging from kindergarten to sixth grade, and have found that in any given population, approximately 10% appeared to have an auditory discrimination deficit. A follow-up study, three years after testing 82 kindergarten and first grade children, showed significant positive correlation at the .05 level with the earlier scores. Although this test has seemed promising, being a simple and easy instrument for the classroom teacher to administer and score, the primary problem in administering it is to be sure that the young child understands the concept of "same" and "different." Also, as reading programs creep steadily downward to age 3 or so, the testing process becomes more difficult. I have found that for most children under 6 the problem of maintaining attention and understanding the directions for listening and responding are generally too difficult. My feeling has been that this test would be most valuable for the first grade teacher prior to embarking on a formalized reading program. I have only used it intermittenly in the last year or so because my interests have become focused on a slightly different area.

I have become very interested in the role of the two cerebral hemispheres in regard to the beginning process of education.

Recent brain research is opening new frontiers of understanding in terms of the functions of these two hemispheres. It has long been known that the left hemisphere is primarily the seat of verbal and linguistic functioning, but we are just beginning to understand the role of the right hemisphere.

Current research suggests that each cerebral hemisphere has its own unique function: the left hemisphere generally controlling verbal reactions and the right hemisphere the affective domain as well as specific distal tasks (Penfield & Roberts, 1959; Delgado, 1969; Dimond, 1970; Sperry, 1975; Gardner, 1975). Schwartz, Davidson, and Maer (1975) report on right hemisphere lateralization for emotion, using lateral eye movement measures for assessment. Cognitive questions evoked movement of the right eye, suggesting activation of verbal and sequential processes associated with the left hemisphere (activation tends to produce orientation to the contralateral side of the body) while spatial/emotional questions evoked left eye movements.

Research using electrodes attached to the head during the performance of tasks (a technique developed by Galin and Ornstein) suggests that although each hemisphere appears to have clear functions, there is an overlapping of hemispheric functioning in some tasks. The right hemisphere seems to be primarily related to holistic, abstract and spatial processing - intuitive flashes but it is also suggested that these are not clear "brain splittings."

Geschwind states in his article Specializations of the Human Brain in Scientific American, Sept. 1979, that:

> "Although the partitioning of linguistic functions among several sites in the cortex is now supported by much evidence, the rigidity of these assignments should not be overemphasized. The pessimistic view that damage to tissue in these areas inevitably leads to a permanent linguistic impairment is unwarranted. Actually a considerable degree of recovery is often observed."
>
> "Although the detailed mechanism of recovery is not known, it has been established that some groups of patients are more likely than others to regain their linguistic competence. Children, particularly children younger than eight, often make an excellent recovery. Left-handed people also make better progress than right-handers. Even among right-handers those who have left-handed parents, siblings or children are more likely to recover than those with no family history of left-handedness. The relation between handedness and recovery from damage to the language areas suggests that cerebral dominance for handedness and dominance for language are not totally independent."

This further question, the relationship between cerebral hemispheres and handedness, has involved considerable research over the past 50 years. Orton, in 1937, hypothesized that children with dyslexia suffered from unclear dominance. Handedness is considered contralateral to the dominant hemisphere so that right handers are left brain dominant and left handers are right brain dominant. Some earlier theories suggested that children with cross dominance, that is right eye and left handedness or vice versa, ran a high risk of being problem learners. This theory has been pretty well ruled out with some theorists suggesting that handedness varies with the task to be done.

Studies by Belmont and Birch (1963), Crinella, Beck and Robinson (1971), and Annett and Turner (1974) suggest that hemispheric dominance does not imply ipsilaterality in all motor behaviors. Handedness must be viewed in the light of the task performed. Mixed handedness is apparent in many tasks. In a study by Ingram (1975) it appeared that the non-preferred hand was better at differential finger movements than the preferred hand. In my research testing laterality in children under 12, I have found that about 40% have cross-dominance.

Semmes (1968) suggests that the differences in hemispheric functioning may be that of focal (left) and diffuse (right) with the former phylogenetically advanced over the other (hence language function in the left hemisphere), which supports the earlier notion that handedness is related to speech. This theory agrees

with studies which show that a higher incidence of subjects diagnosed as learning disabled or exhibiting deficient perceptual-motor integration and/or deficient intellectual functioning are left-hand-left-eye dominant (Zangwill, 1962; Koos, 1964; Flick, 1966). Coleman and Deutsch (1964) suggest that if existing tests of hand, eye, and foot preference are assumed to measure some underlying pattern of cerebral dominance, incomplete cerebral dominance does not appear to be causally related to reading disability, and even if such a relationship were demonstrated conclusively, the nature of the relationship would still have to be determined. The question to be answered would be whether reading disability is related to a lack of complete unilateral cerebral dominance or whether both were related to some underlying maturational defect.

Little evidence has been found to substantiate the suggestion that eye dominance is related to hand dominance. If the two hemispheres of the brain are considered to have generally undifferentiated functions until cerebral maturity is reached at the age of 10 or 11, asymmetrical hand-eye preferences would be expected, and one would assume mixed laterality as measured in specific tasks to be as common as ipsilaterality.

Annett and Turner (1974) hypothesize a model for the inheritance of cerebral dominance in which hand dominance is determined by two alleles: D (right hand), R (left hand). This model is supported by Satz, Fennell and Jones (1969) as well as Levy and Naglaki (see Sperry, 1975).

You are probably wondering what all of this has to do with auditory attending skills. My interest has been to try to identify individual capabilities in young children so that their formalized education will build upon these strengths. It seemed to me that it might be possible to discriminate children who were primarily "Left Brained" from "Right Brained" by means of simple, easy to administer tests. Aspects of this test are found in other tests. You might call this a gross simplification of Galin and Ornstein's sophisticated electrode test.

Methods

In the summer of 1979 a pilot study, using 10 preschool children, resulted in the final testing procedure which took place in the fall of 1979. Human subject clearance was granted by the University of Delaware Research Committee to carry out this study.

In order to try to tap the linguistic or left hemisphere functioning, I composed a story of approximately 650 words that I thought would appeal to 5-year-olds. It tells the story of a five-year-old named David who goes by plane to visit his grandparents on a farm. There are 77 specific details to the plot, including what he packed in his suitcase, an airport sequence, the animals on the farm, and what he ate for dinner. The story was taped and lasts 7 minutes. The child is instructed to listen well so he or she could tell the whole story again when it was finished. At the conclusion,

each child was asked to repeat the story. These responses were taped.

Tangram pieces were used for the abstract (or right hemisphere) portion of the test. Twelve puzzles were presented to each child, using from 2 to 6 tangram pieces. (Tangrams consist of 5 triangles of varying sizes, 1 parallelogram and one square which can be formed into a square, thus each piece bears an exact relationship to the other. Two small triangles are equal to the small square, the parallelogram is equal to the 2 small triangles, etc.). Finding the exact relationship for each puzzle appeared to me to be novel, taxing, and a potential index of the ability to "think holistically." A perfect score was 36.

Forty two children were tested, using 21 children from an inner city church sponsored day care center and 21 from a private suburban kindergarten. All but 4 of the day care children were black, although the parents of these children are mostly clerical and professional persons and, therefore, were somewhat similar in economic class to those children in the private school. All of the latter were white. Permission for testing was granted by each parent, but information on socio-economic aspects of each family was not sought. Each child was tested in 2 separate sessions, on different days to avoid fatigue and restiveness; one for the verbal and one for the abstract. An attempt was made to confine the

testing period to less than 20 minutes, although this varied considerably, depending on the child. All of the subjects required prompts on the story by the investigator, who waited until the child had finished and then asked such questions as "Do you remember what the boy packed in his suitcase?" "What did he see in the barn?" A score sheet was utilized with the investigator checking off the details as the child related the story, as well as details which were the result of prompting. A record was kept of the number of prompts and the length of time each child took from the beginning of his or her telling of the story. The verbal score consisted of the total number of words the subject used, a separate score for the number of correct details, and the number of prompts.

Similar prompting was used with the Tangrams when the child seemed puzzled or helpless. The investigator simply asked, "Do you want some help?" and if the child assented, the investigator moved one tangram piece into place. Scoring for the Abstract (Tangrams) consisted of the number of correct solutions by each puzzle piece plus a record of "Helps" and the total time. In addition, each child was asked to print his or her name, as a simple handedness record, and was given a kaleidoscope to sight through, placed central to the child for a record of eye and hand use.

Results

Twenty males and 22 females participated in the study. The mean age was 62 months with a range of 57 to 69 months.

Six of the males were black, 1 was Korean, and 1 was Hispanic. Ten of the females were black. Eighty seven percent of the children were right handed, but only 62% were right handed and right eyed. Eight percent were left handed and left eyed, 26% right handed and left eyed and 4% were left handed and right eyed. In other words, 30% of this population had mixed laterality as measured. Two of the subjects are not included in this count as one appeared to be ambidextrous and the other used first one eye and then the other on three measurement counts. Both of these "ambi" children were females and scored comparatively well on both measures of Verbal and Abstract.

The similarity of eye and handedness in the two centers was remarkable. In both centers, 12 children were right handed and right eyed, 5 were right handed and left eyed, 1 was left handed and right eyed and 2 were left dominant in 1 center with 1 left dominant in the other.

It was somewhat difficult to get a clear picture of Verbal capacity in this measure as the scores ranged from a low of 16 to 318, giving a skewed effect and an inflated mean of 102 with a standard deviation of 70. The median, however, was 8.4 words. By dropping the top 2 scores of 307 and 318 and the bottom 2 scores of 16 and 26, a new mean of 97 is achieved with a standard deviation of 23. Using this new mean gives a slightly more realistic picture of the verbal capacity of the majority of the subjects. Twenty three children fell below this mean and 19 above. Although this approach

was somewhat productive in analyzing verbal scores, the investigator decided a clearer picture would be obtained by taking the Total Words Score and subtracting from it the number of prompts plus the separately scored detail accuracy list. This new score proved to be more meaningful and manageable. The mean for verbal details was 16 with a range of 4 to 30 and a S.D. of 6, while the mean number of prompts was 11 and a S.D. of 5.

Scoring the Abstract was simpler as there was one clear score, plus the number of helps. The same process was used in computing an Abstract score as was used in Verbal, that is the number of helps was subtracted from the total completed. The mean score for Abstract was 29 with a range of 10 to 36 and a S.D. of 6. The mean for helps was 6 with a S.D. of 4.

Analysis of variance was used to see whether there were any statistically significant differences between the variables. Significance was found in Verbal ($F= 5.68$ df 1,38 $p < .02$), Total Words ($F= 7.29$ df 1,38 $p < .01$) and to a lesser degree in Abstract ($F= 3.80$ df 1,38 $p < .06$). A profile of the Ss was developed to see whether there were major discrepancies between Verbal and Abstract, subject by subject. Twenty one, or 50% of the children were found to have major discrepancies. In other words, it was clear from examining the sets of scores that half of the children were considerably stronger in one measure that the other. Thirteen of these children showed strength in the Verbal over Abstract and nine

showed more strength in the Abstract area. Of this sample of 21 showing clear discrepancies, 10 were either cross dominant or ambidextrous.

However, in looking closely at the profiles of each child, the investigator selected out all of those children who had a Verbal score of 100 or more. Of these 12 children, 8 were right handed, 3 were left handed and 1 was ambidextrous. Five of these were cross dominant and males and females were equally represented in these high verbal scorers. A similar analysis was given to those children scoring 28 or more in Abstract. Again, 12 children fell into this category, with 9 right handed and 3 left handed, 5 were cross dominant and there were 7 females and 5 males in this category.

Discussion

The above mentioned results are provocative. They appear to suggest that children between the ages of five and six show clear differences in what might be called learning styles or strengths. It should be pointed out that 9 of the 42 children tested were high scorers in both categories, and of these 9, 3 were cross dominant and 2 were left handed and left eyed.

Where does all of this lead us? Clearly the first priority would be to carry out more of this kind of testing. Although the primary interests of the investigator began in the area of auditory processing, the challenge of trying to identify

children whose abstract (and presumably right hemisphere) capabilities are dominant is hard to resist. There remain those children who show little interest in reading, who draw marvelous pictures, and who are the despair of their first grade teachers. The spectre of cross dominance being a factor in reading failure may not be completely laid to rest, but the question of right hemisphere dominance and its relationship to the kind of sequential processing which is needed in learning to read (presumably left hemisphere dominance) takes on new interest for the teacher of beginning reading. We await with interest the results of ongoing research in this fascinating last frontier of science - the human brain.

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